



Importance of constraining robustly the climate impacts for reconstruction purposes

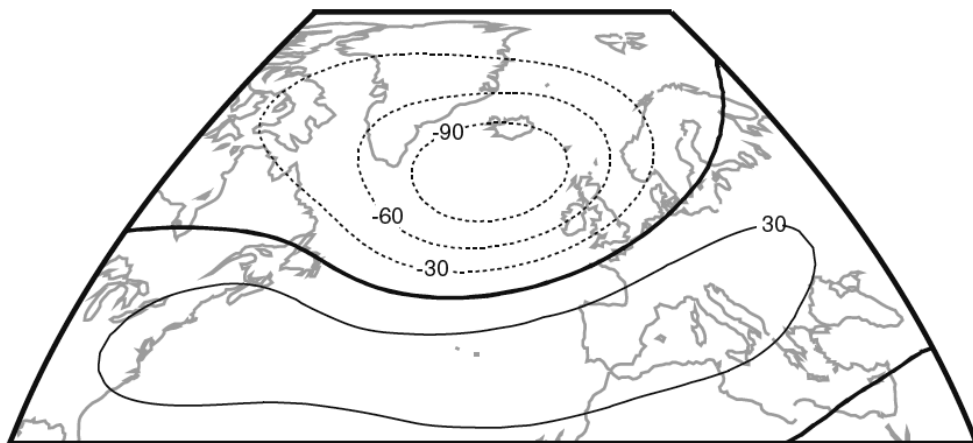
Pablo Ortega

Climate Prediction Group, Earth Sciences Department

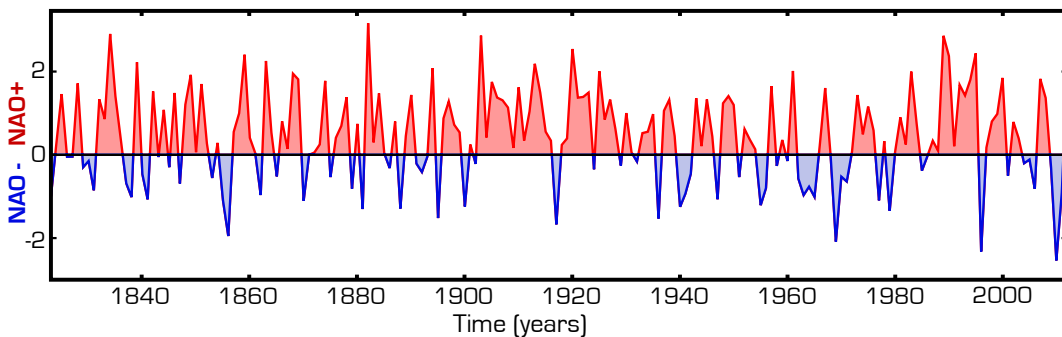
NAO definition and impacts

The NAO is the dominant mode of atmospheric variability in the North Atlantic

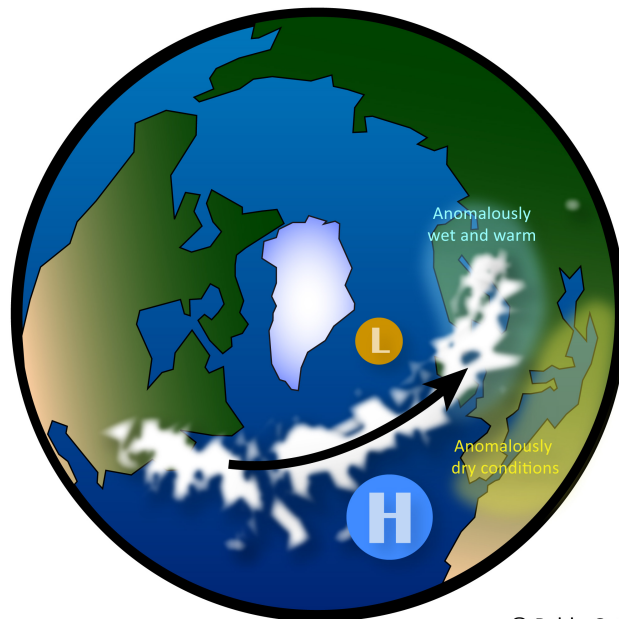
Spatial pattern in SLP



NAO variability since 1823 (Vinther et al 2003)

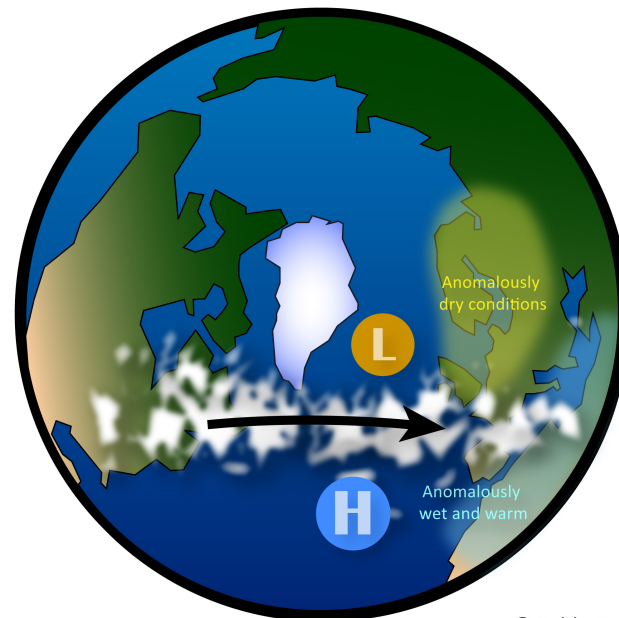


NAO POSITIVE PHASE



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NAO NEGATIVE PHASE

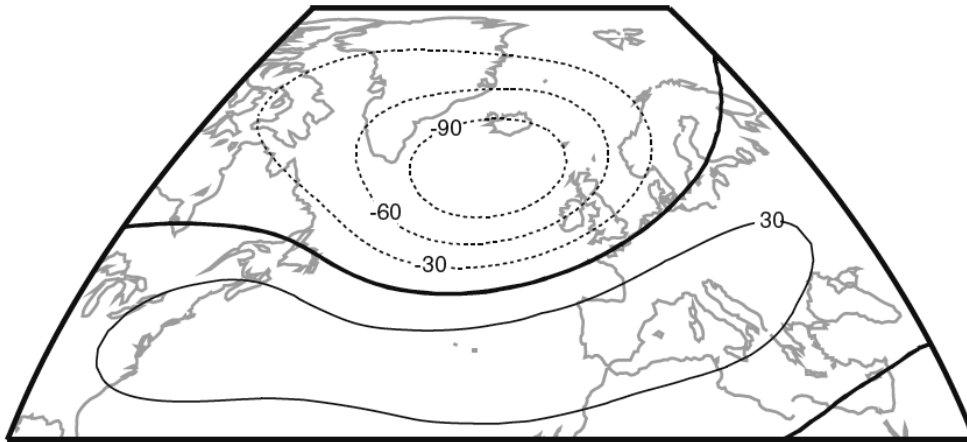


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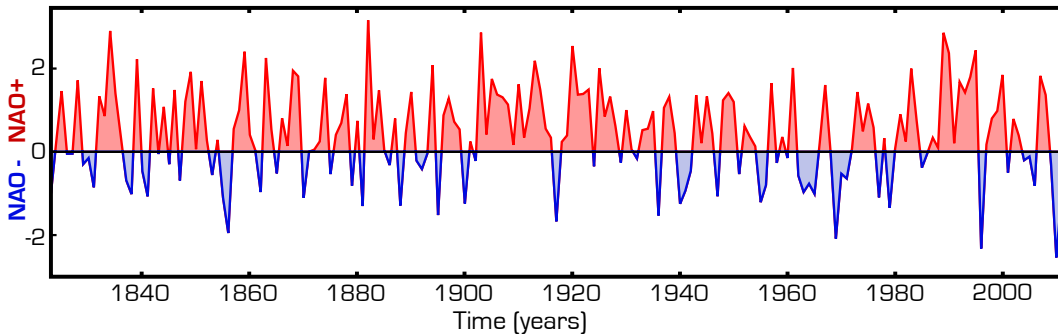
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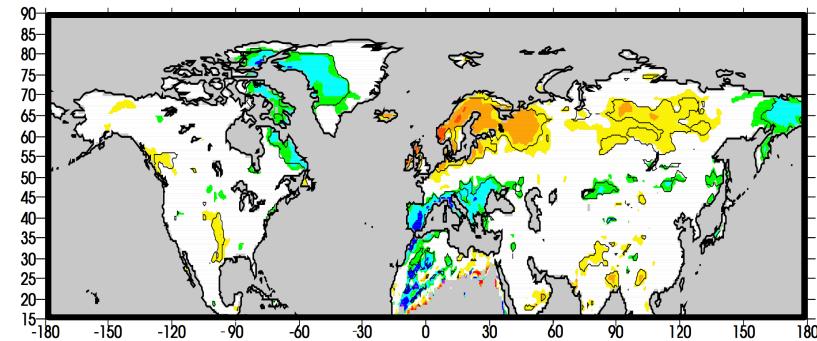


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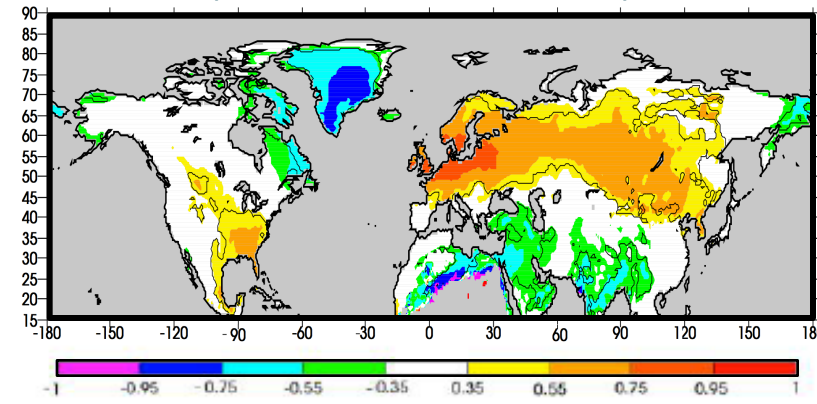


ERA-Interim (1990-2010)

NAO impact on winter precipitation



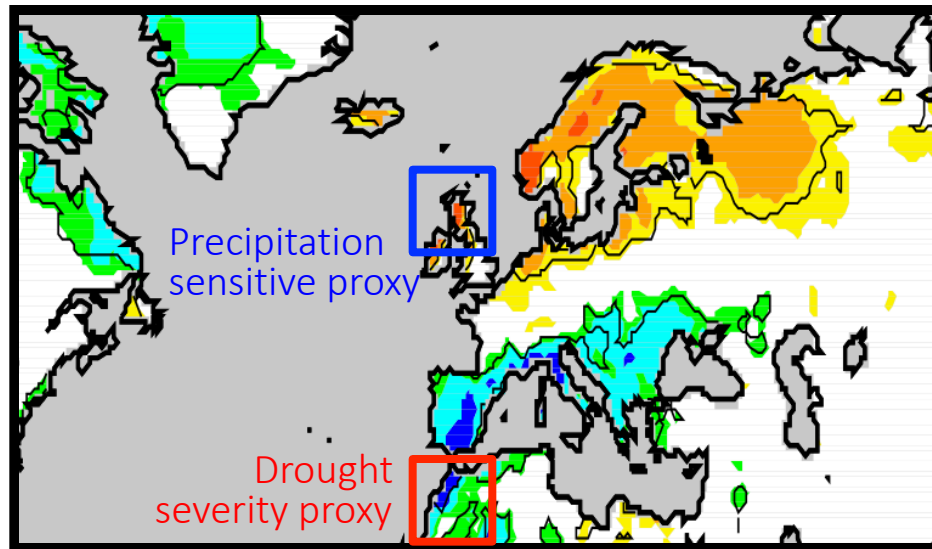
NAO impact on winter temperature



Casado et al (2013)

Evolution of the NAO in the last millennium

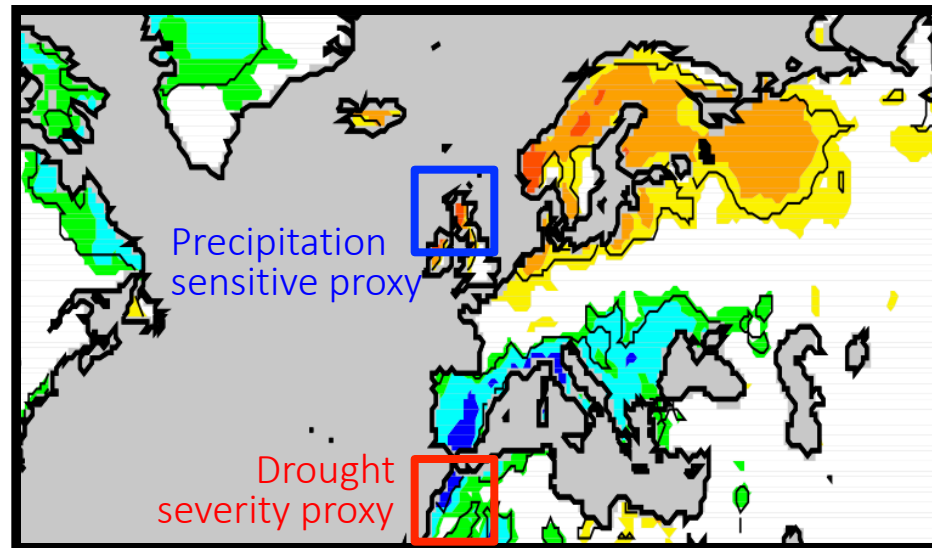
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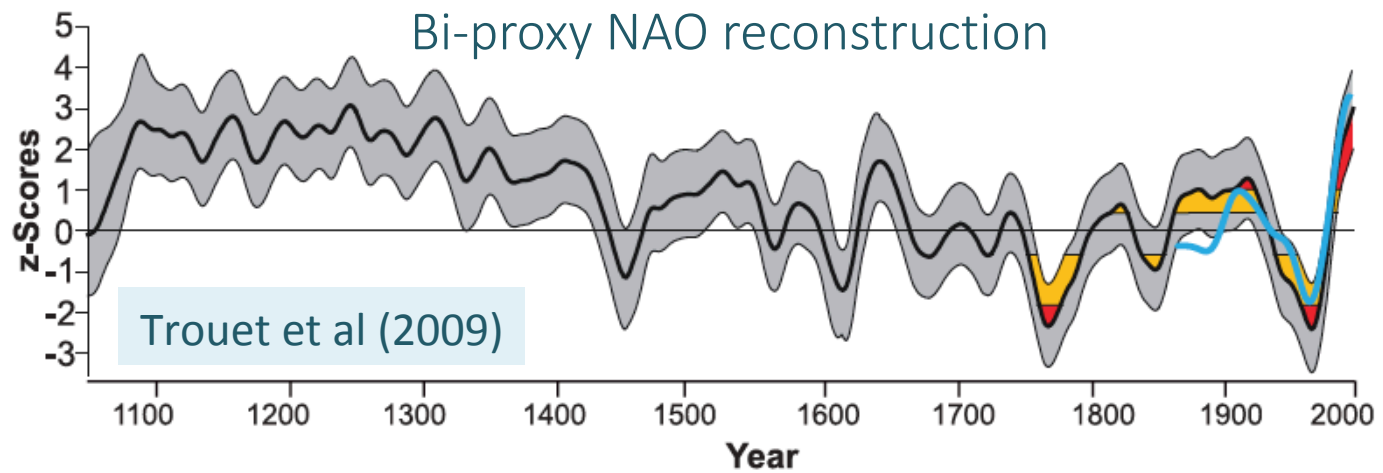
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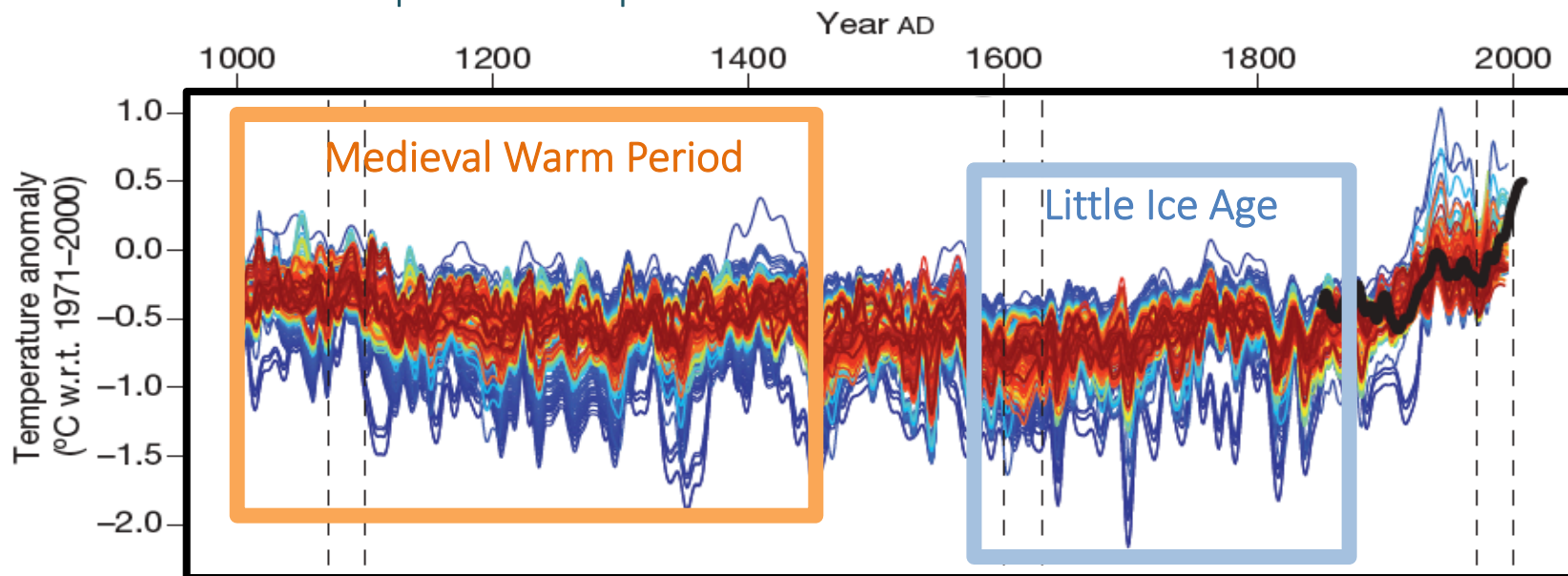


Casado et al (2013)

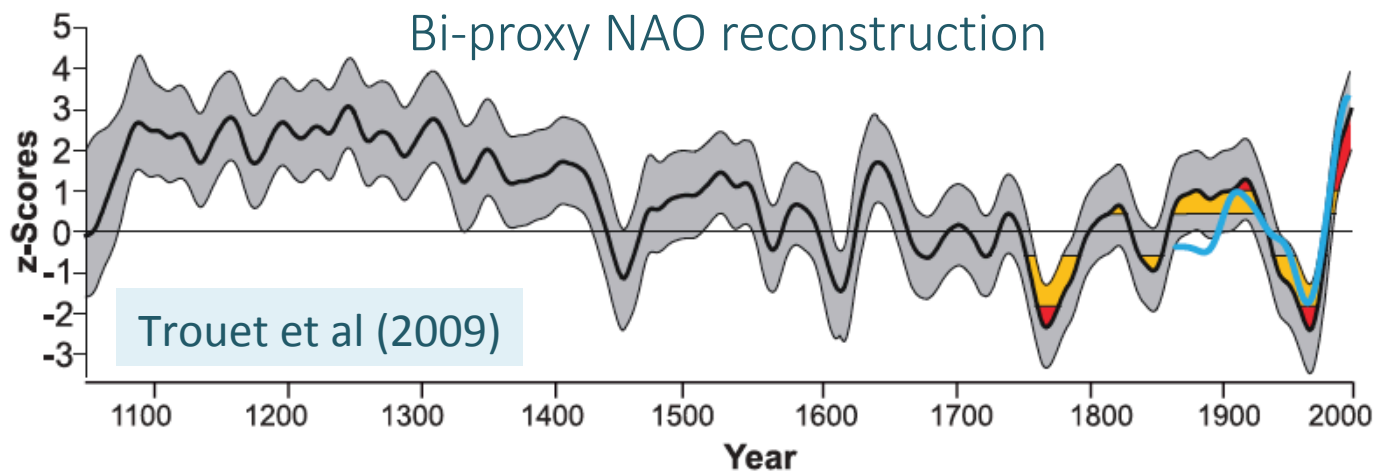


Evolution of the NAO in the last millennium

Northern Hemisphere temperature reconstructions for the last millennium



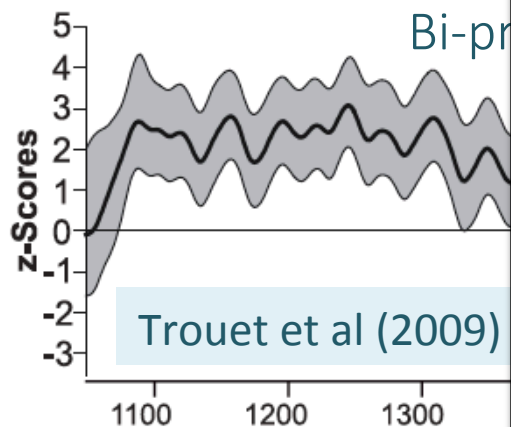
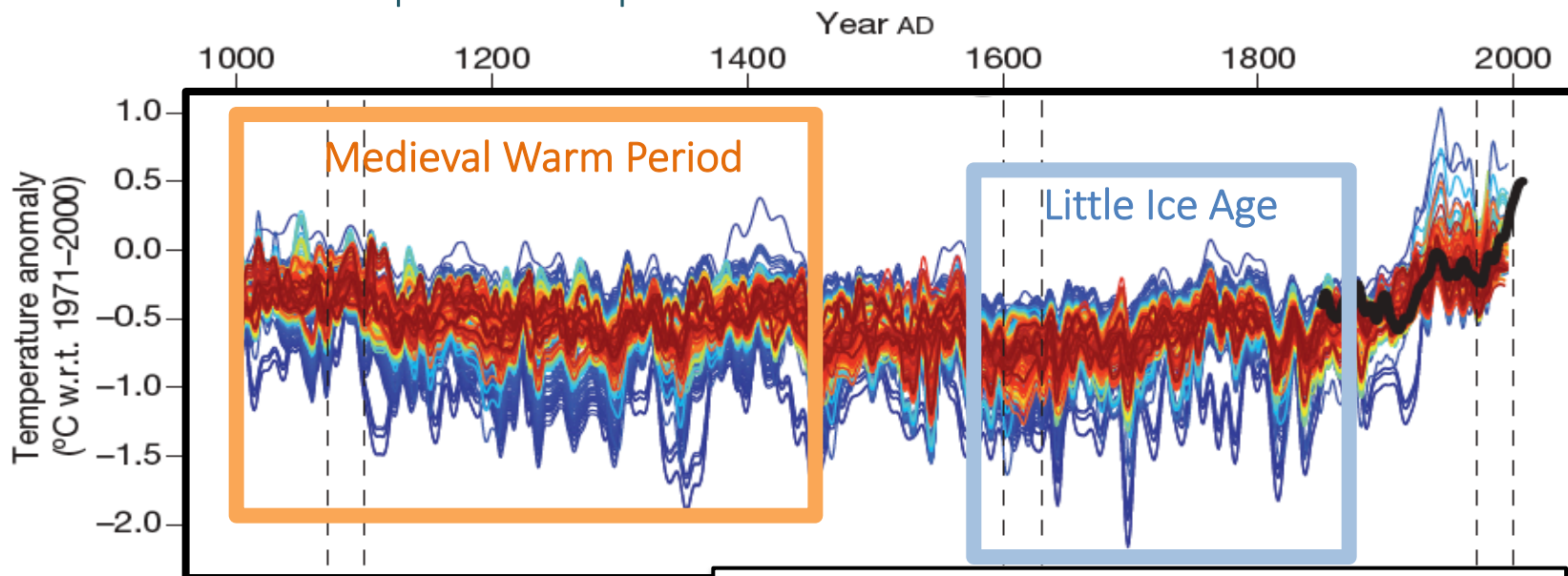
Frank et al (2010)



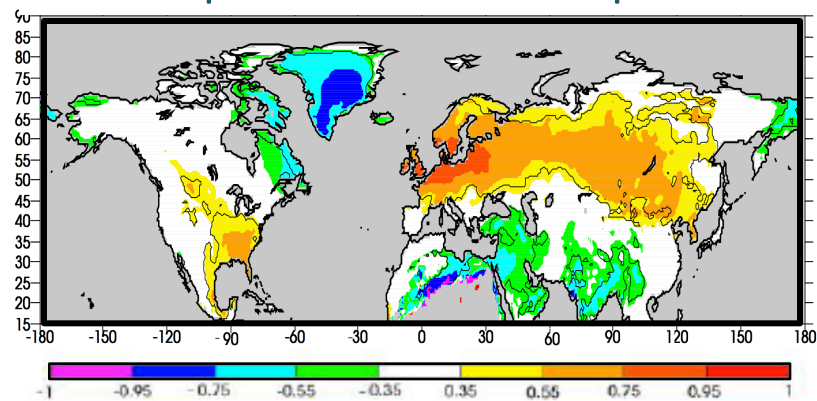
Trouet et al (2009)

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NAO impact on winter temperature



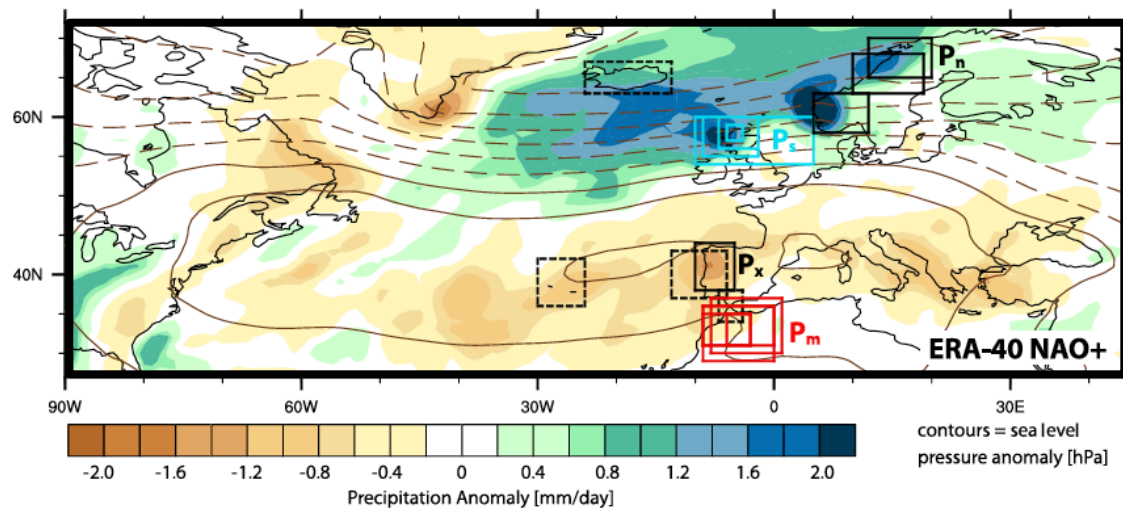
Casado et al (2013)

Robustness of *Trouet's* NAO reconstruction

Perfect model approach

Lehner et al (2012)

NAO correlation with winter precipitation

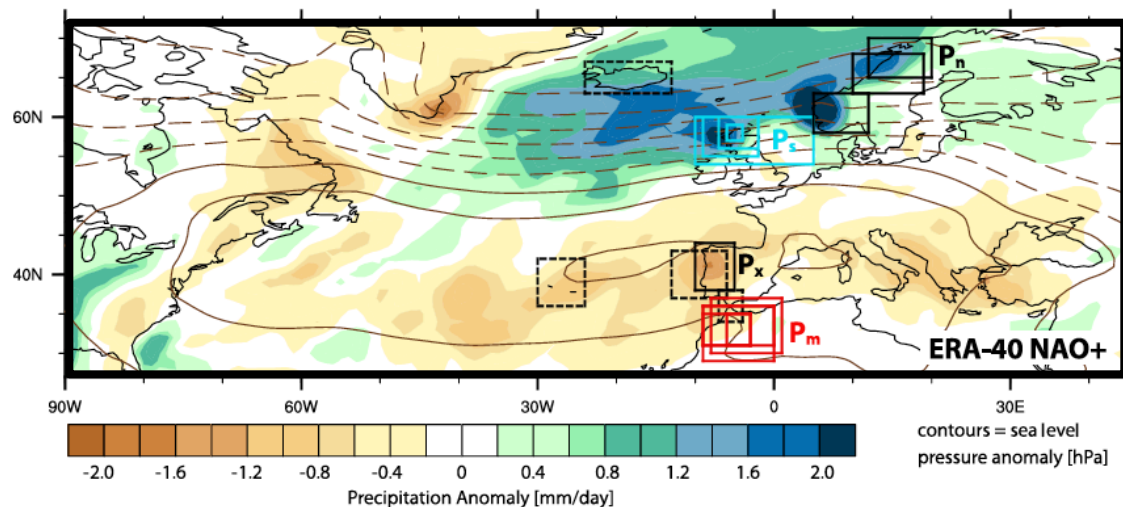


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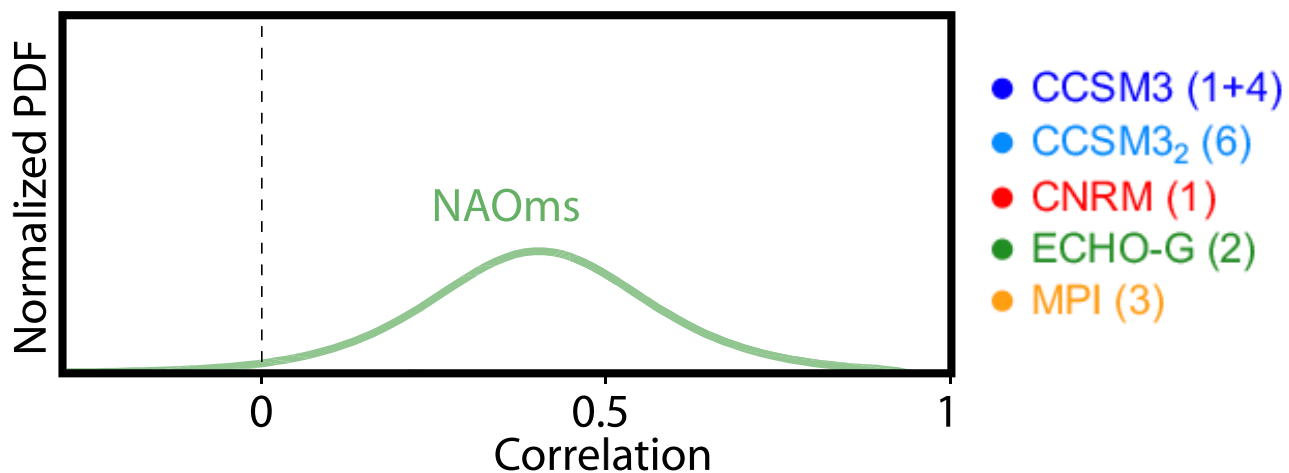
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Normalized PDF of 50-yr moving correlations in PMIP3 millennial runs

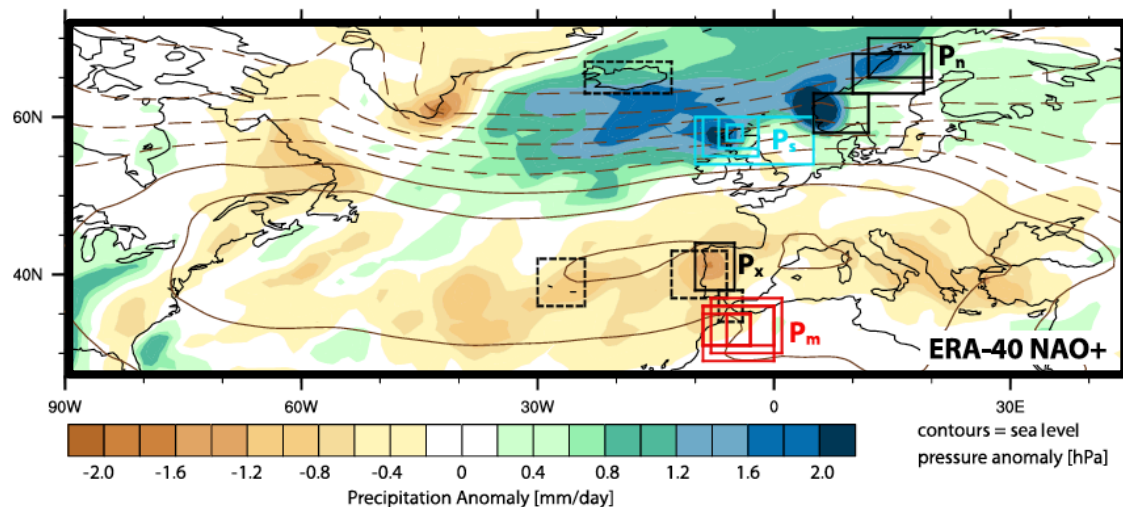


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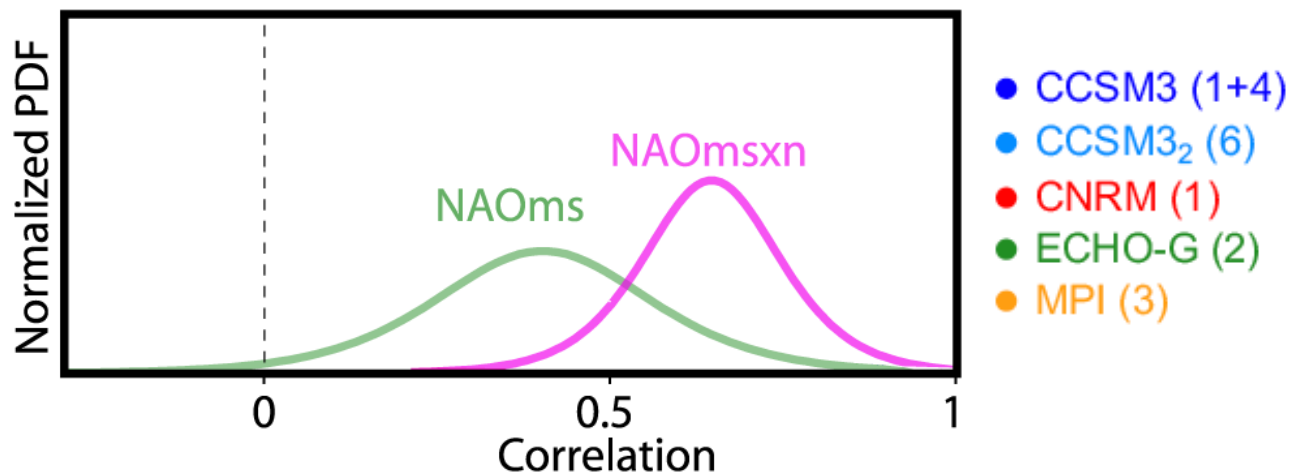
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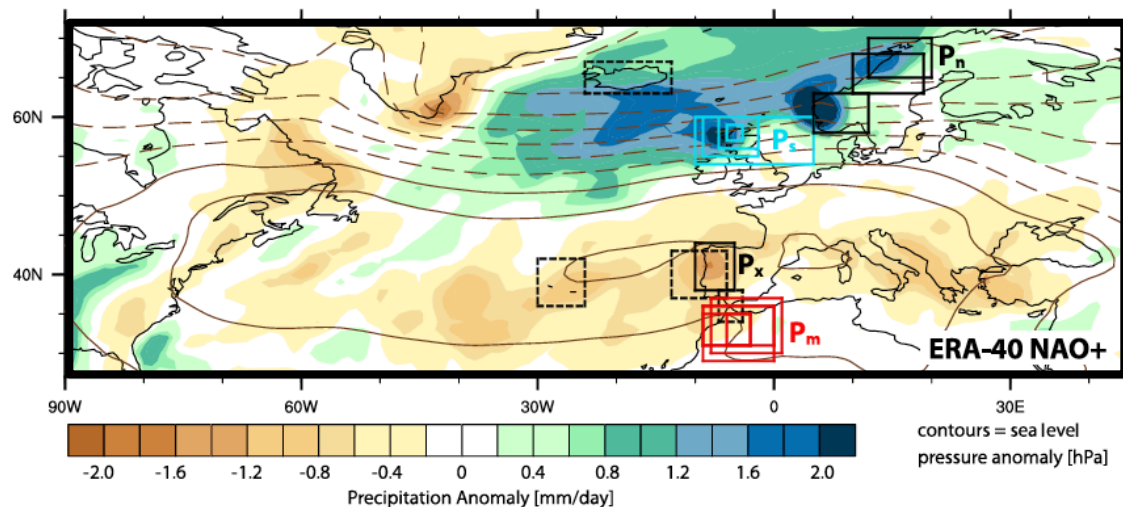
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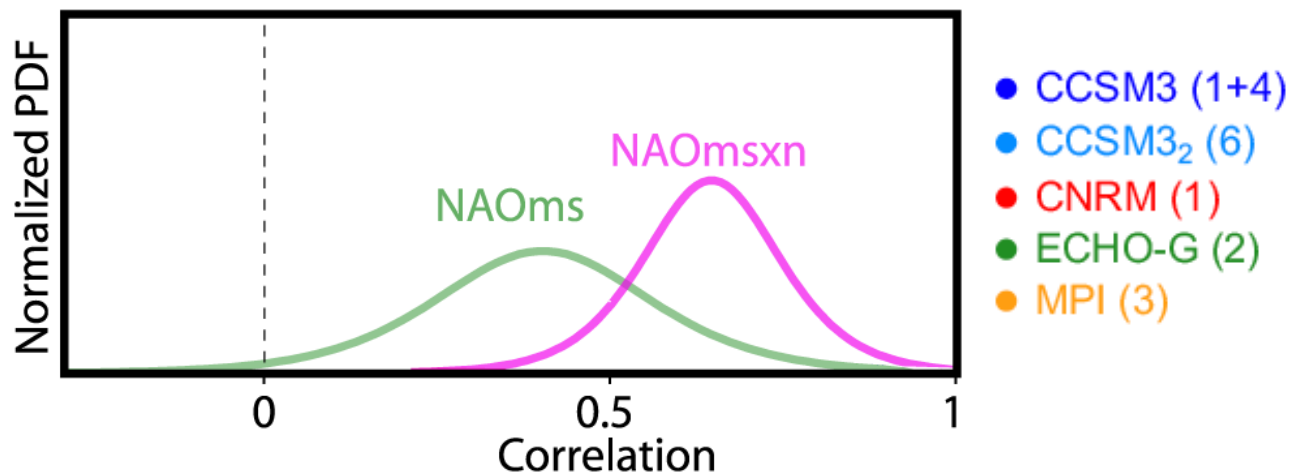
But are there
other proxies?

What do they say?

NAO correlation with winter precipitation

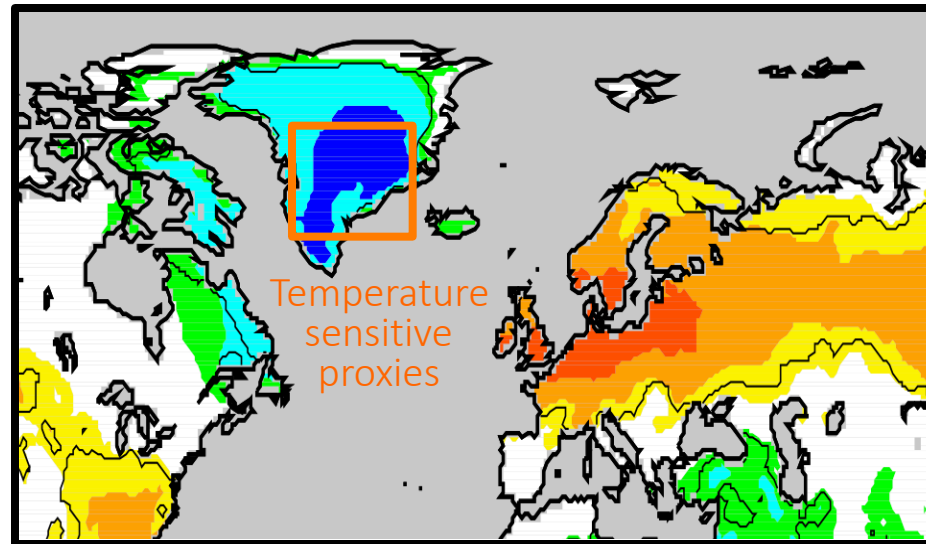


Normalized PDF of 50-yr moving correlations in PMIP3 millennial runs



Evolution of the NAO in the last millennium

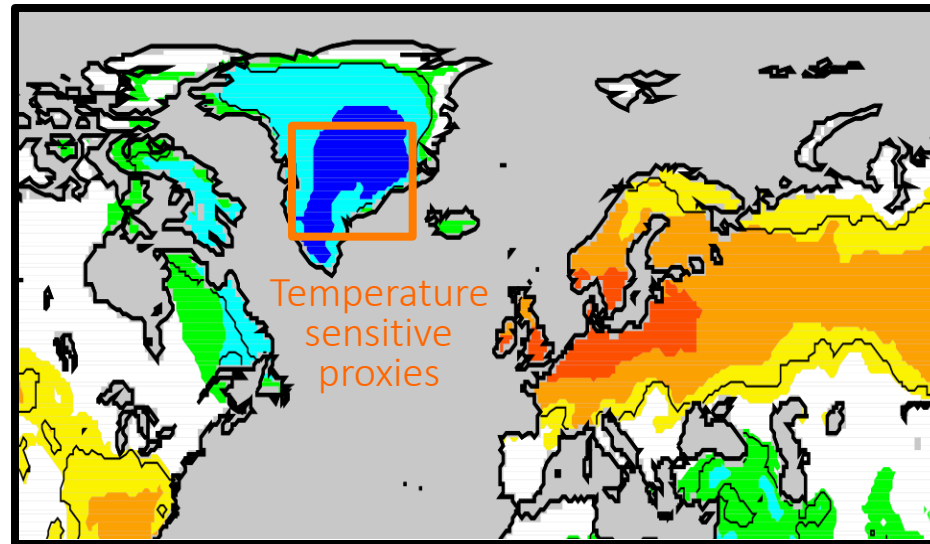
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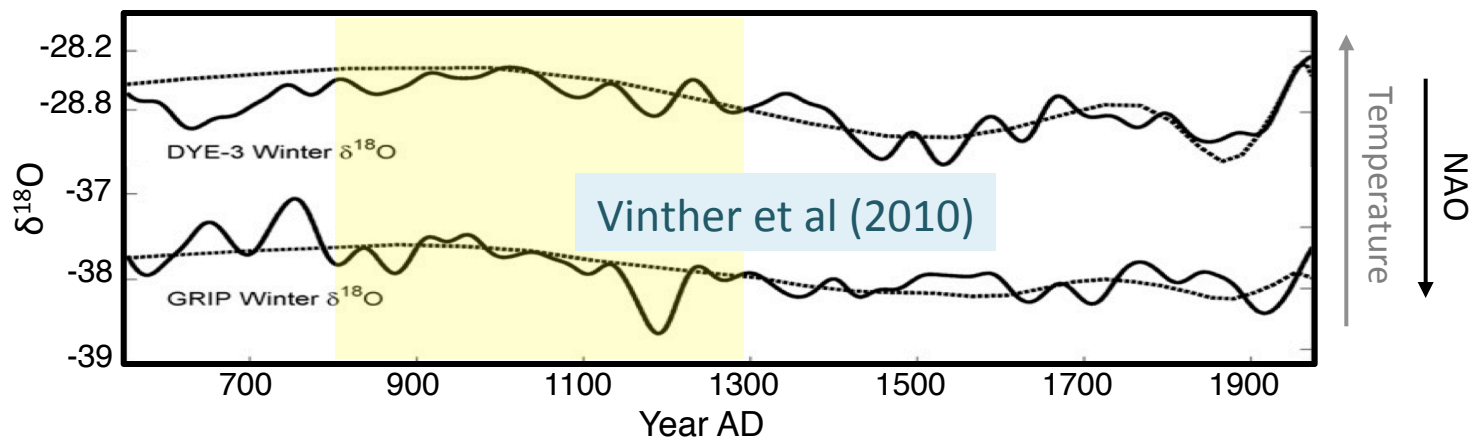
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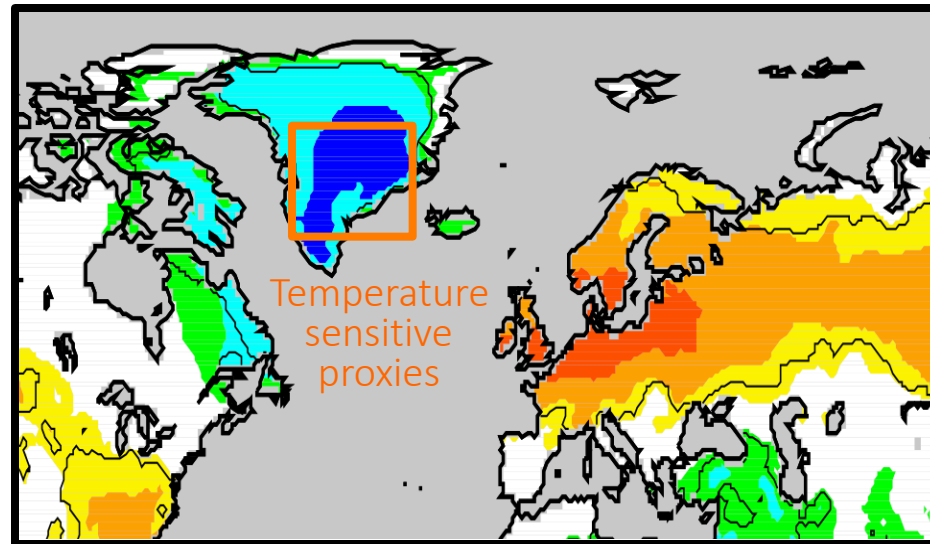
Greenland Borehole and isotope reconstructions



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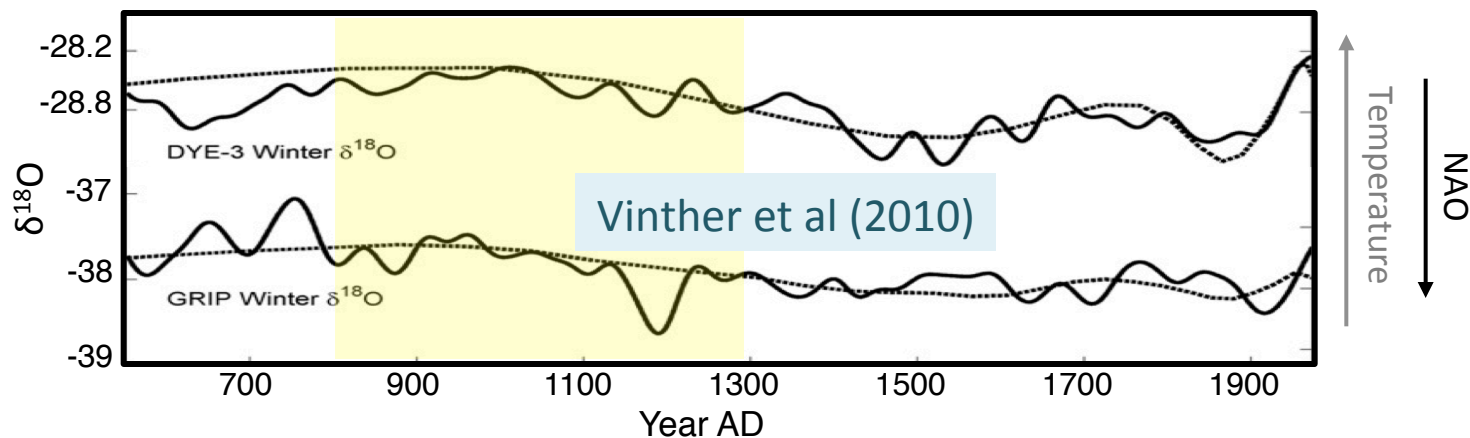
NAO impact on winter temperature

But are these
proxies more
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Casado et al (2013)

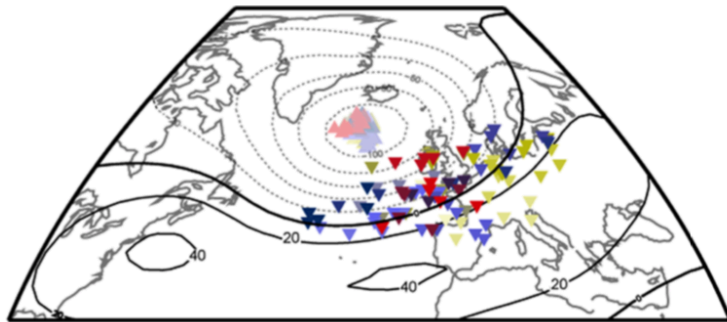
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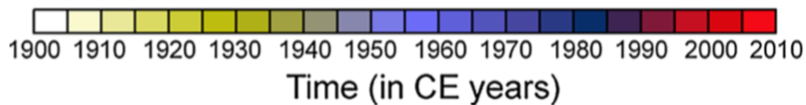
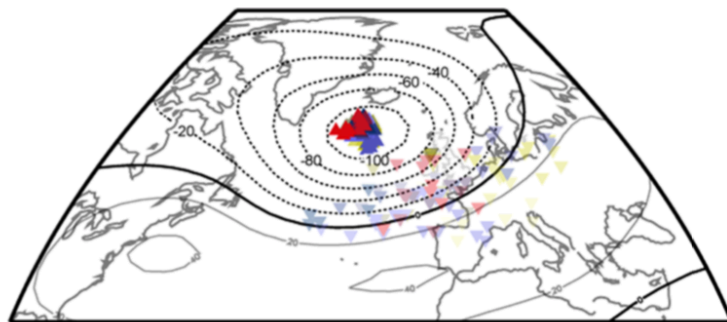
Evolution of the NAO in the last millennium

Average position of the NAO centres of action in 5-year windows

Position Positive Centre



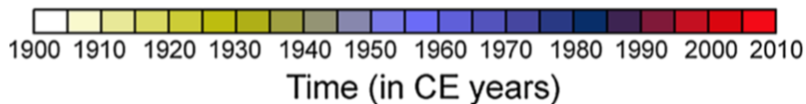
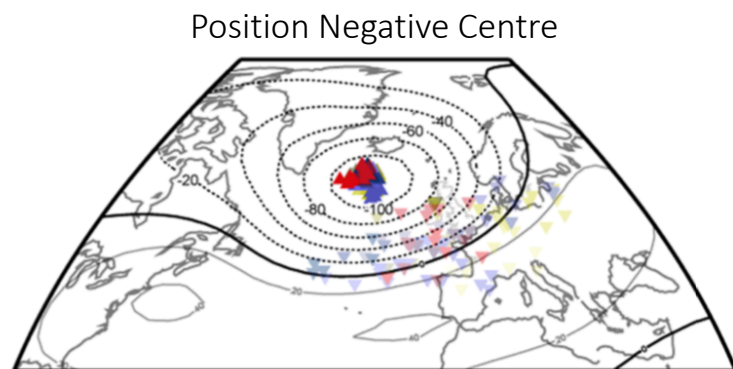
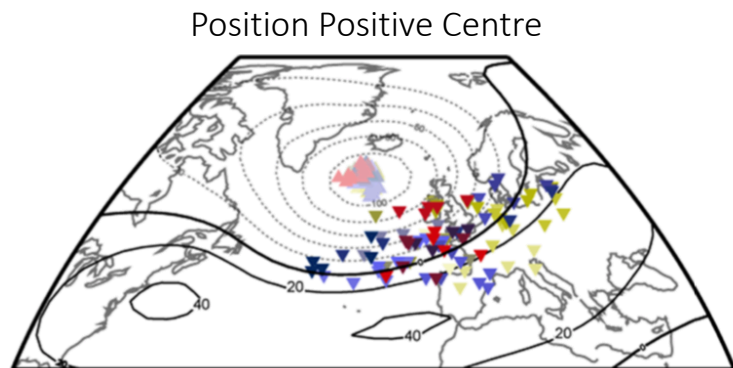
Position Negative Centre



Ortega et al (2014)

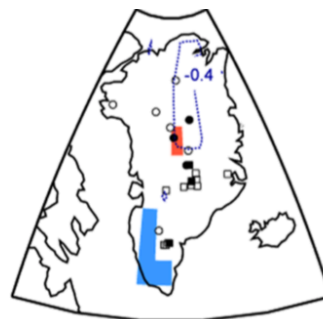
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Average position of the NAO centres of action in 5-year windows



Correlation of shifts in centers of action with temperature

Zonal shifts



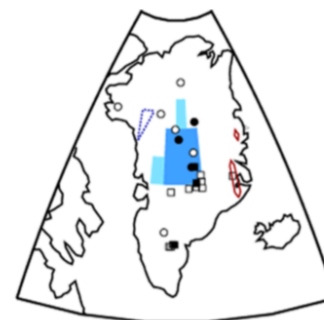
Latitudinal shifts



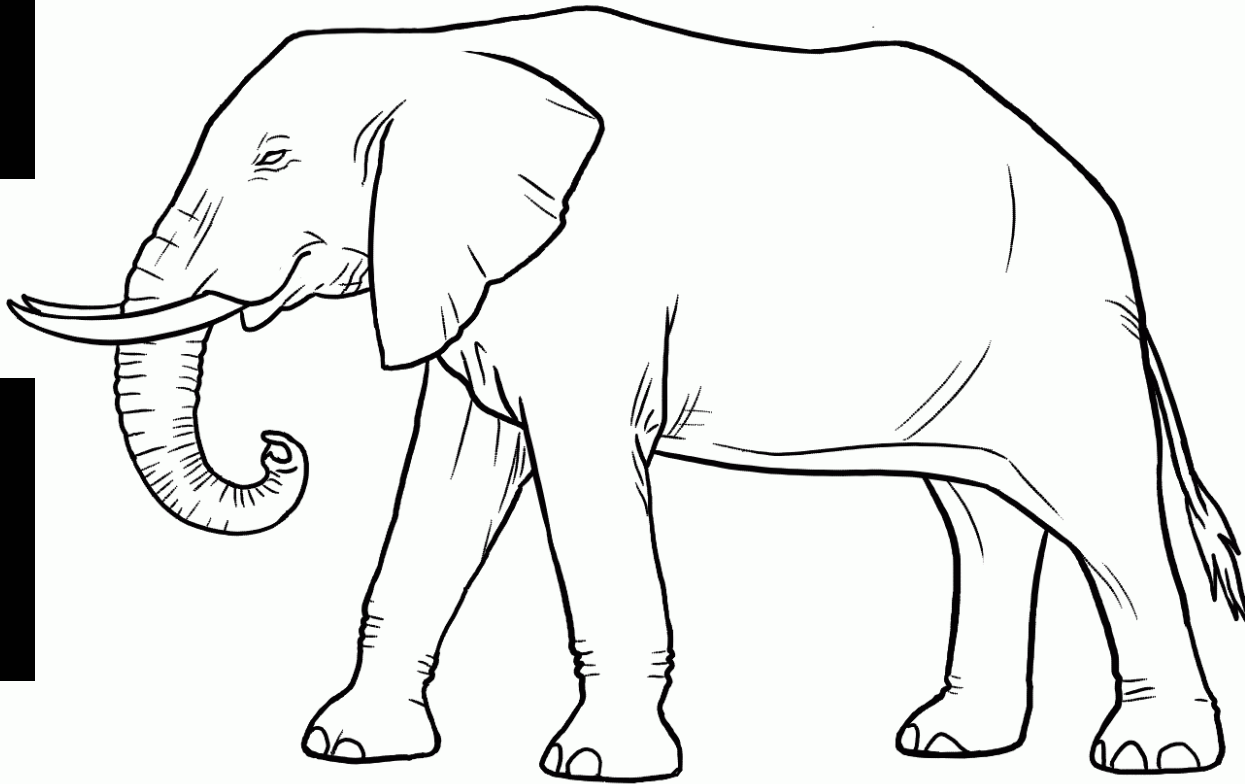
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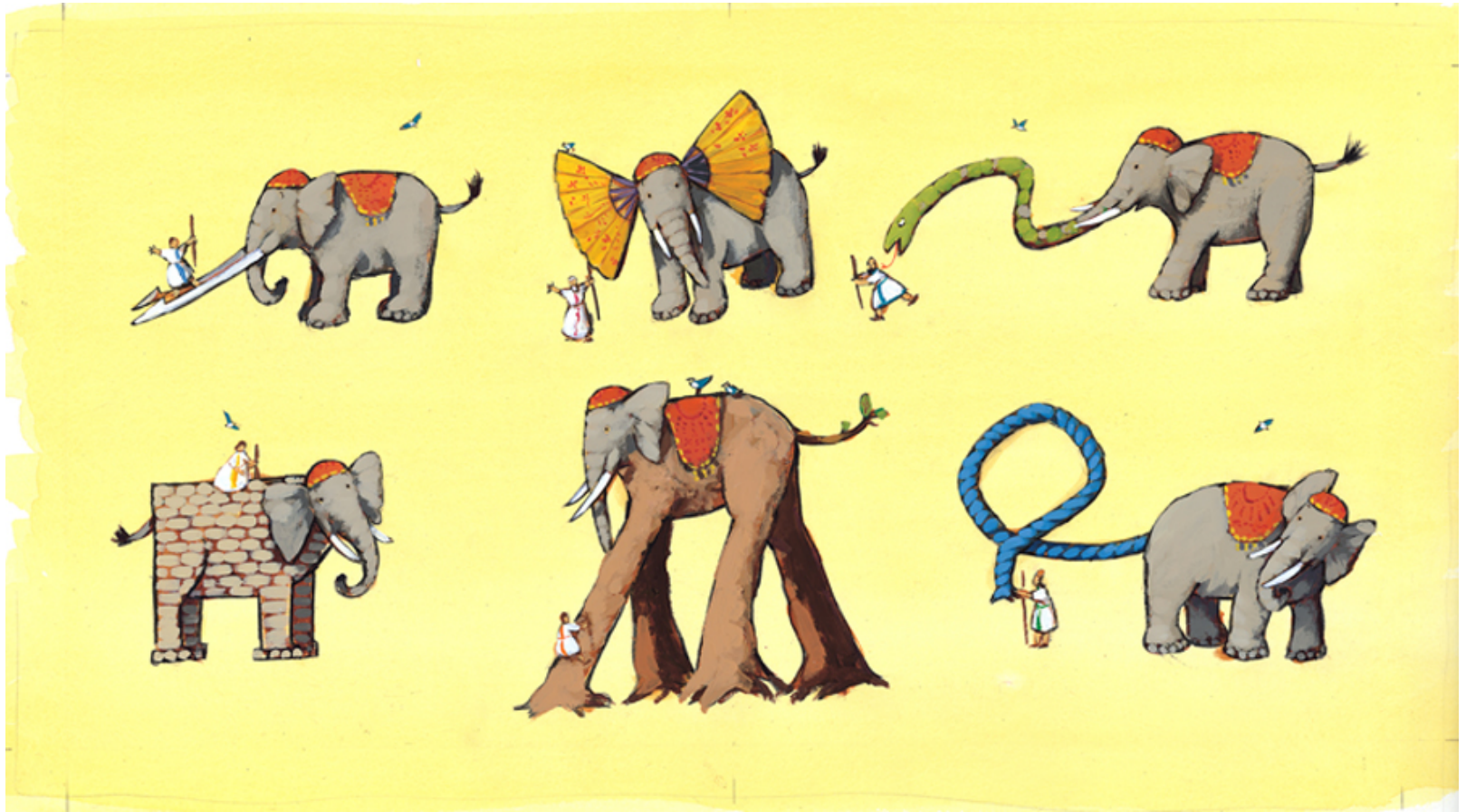
The Elephant analogy



Each proxy can be regarded as a **blind person** sent to meet and tell us about the elephant in the room



Different proxies can tell really different stories...

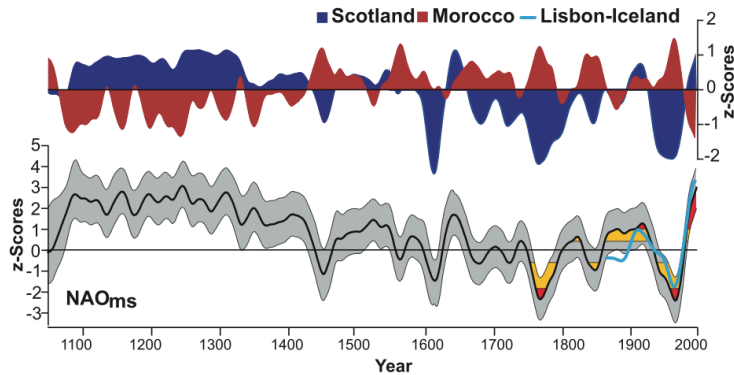


...and yet all be partly right

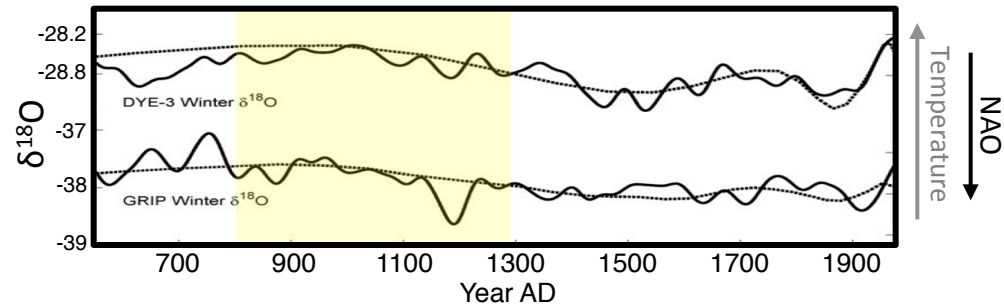
Coming back to the NAO...

...is it possible to reconcile both histories?

Trouet et al (2009)



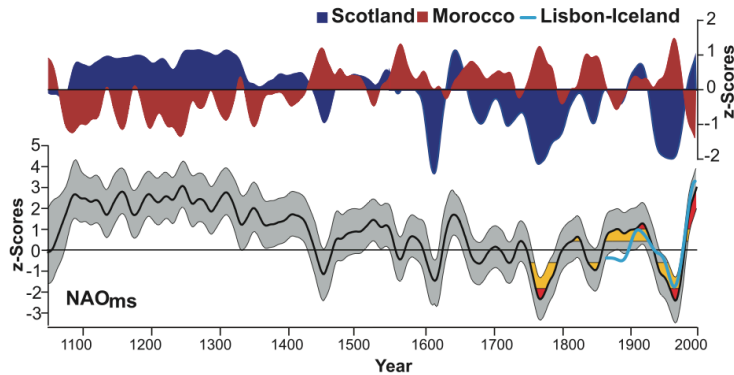
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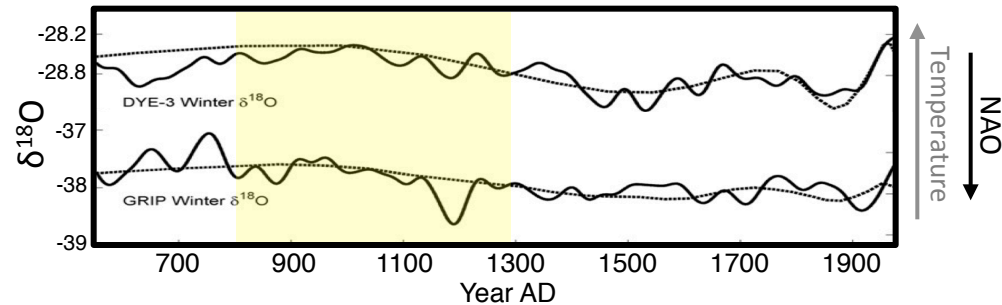
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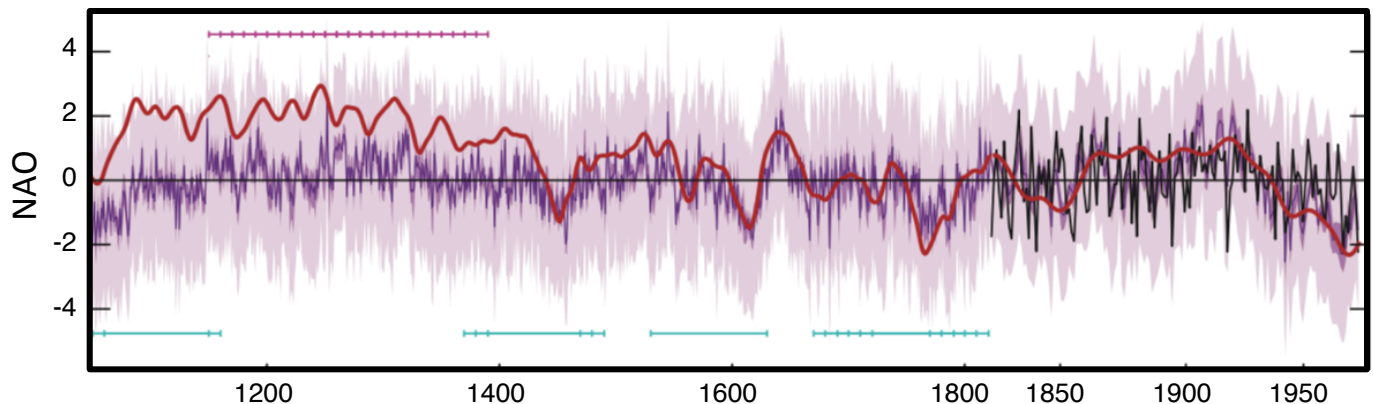
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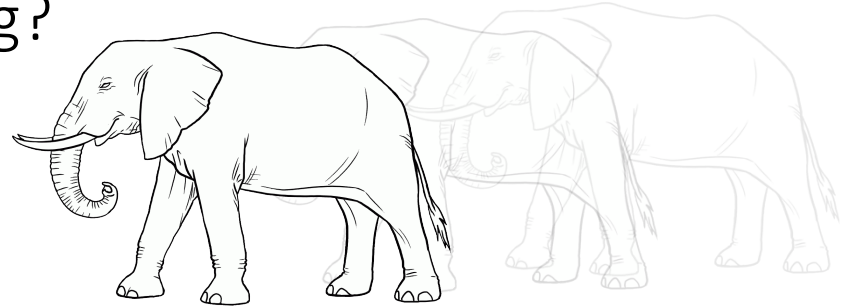
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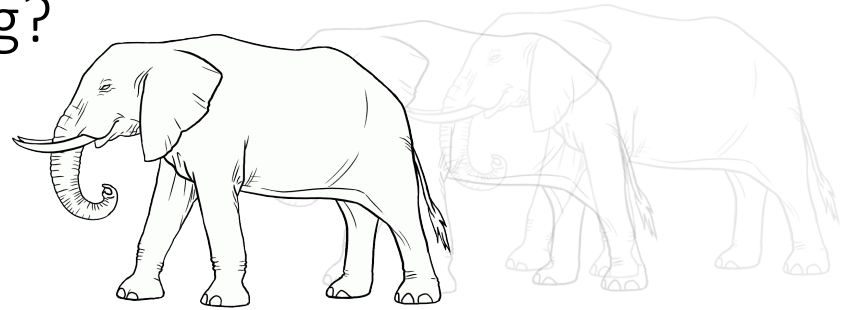


What if our elephant is moving?



All reconstructions assume that the statistical links upon which they are based hold back in time.

What if our elephant is moving?



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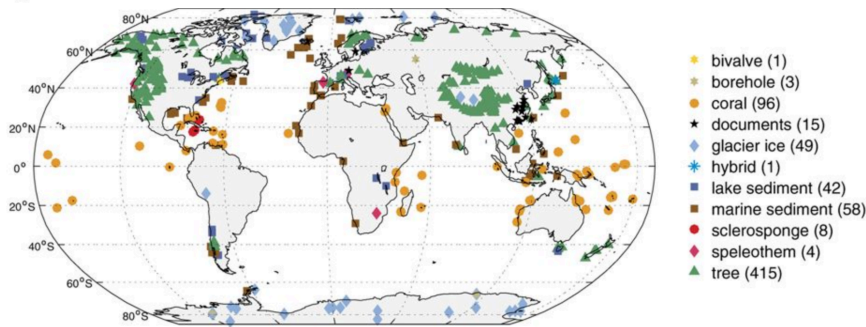
However:

- The centres of action of the climate modes of variability can change, invalidating certain proxies for certain time periods
- Climatic and non-climatic signals recorded by the proxy records can vary from one period to another

Solutions?

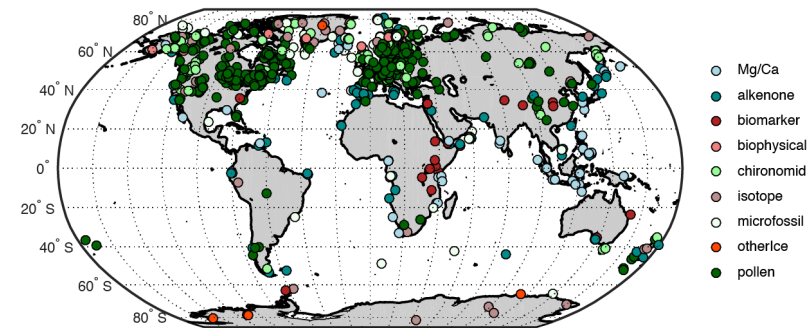
Multi-proxy reconstructions are the best way to circumvent those limitations.

PAGES2K (692 records)



Emile-Geay et al (2017)

TEMP12K (667 sites)

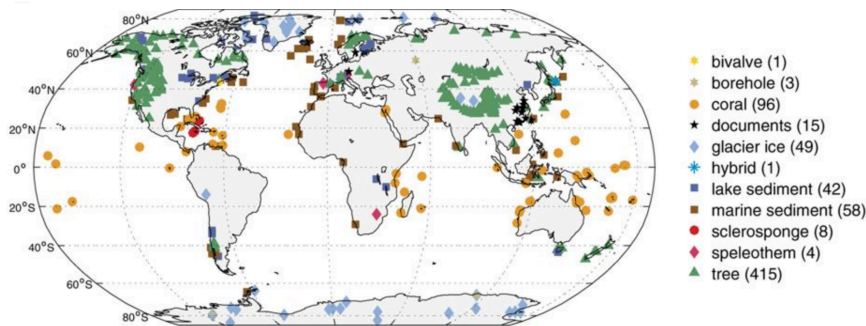


Routson et al (2019)

Solutions?

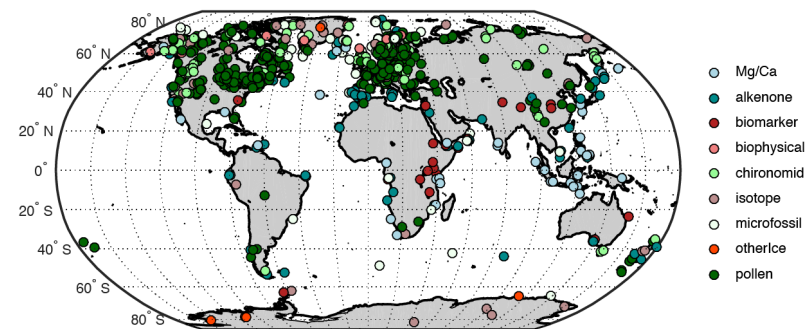
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Models are also a powerful tool to:

- Analyse the past forced variability
- Test the realism of the teleconnections, and their stationarity in time
- Validate the reconstruction methods

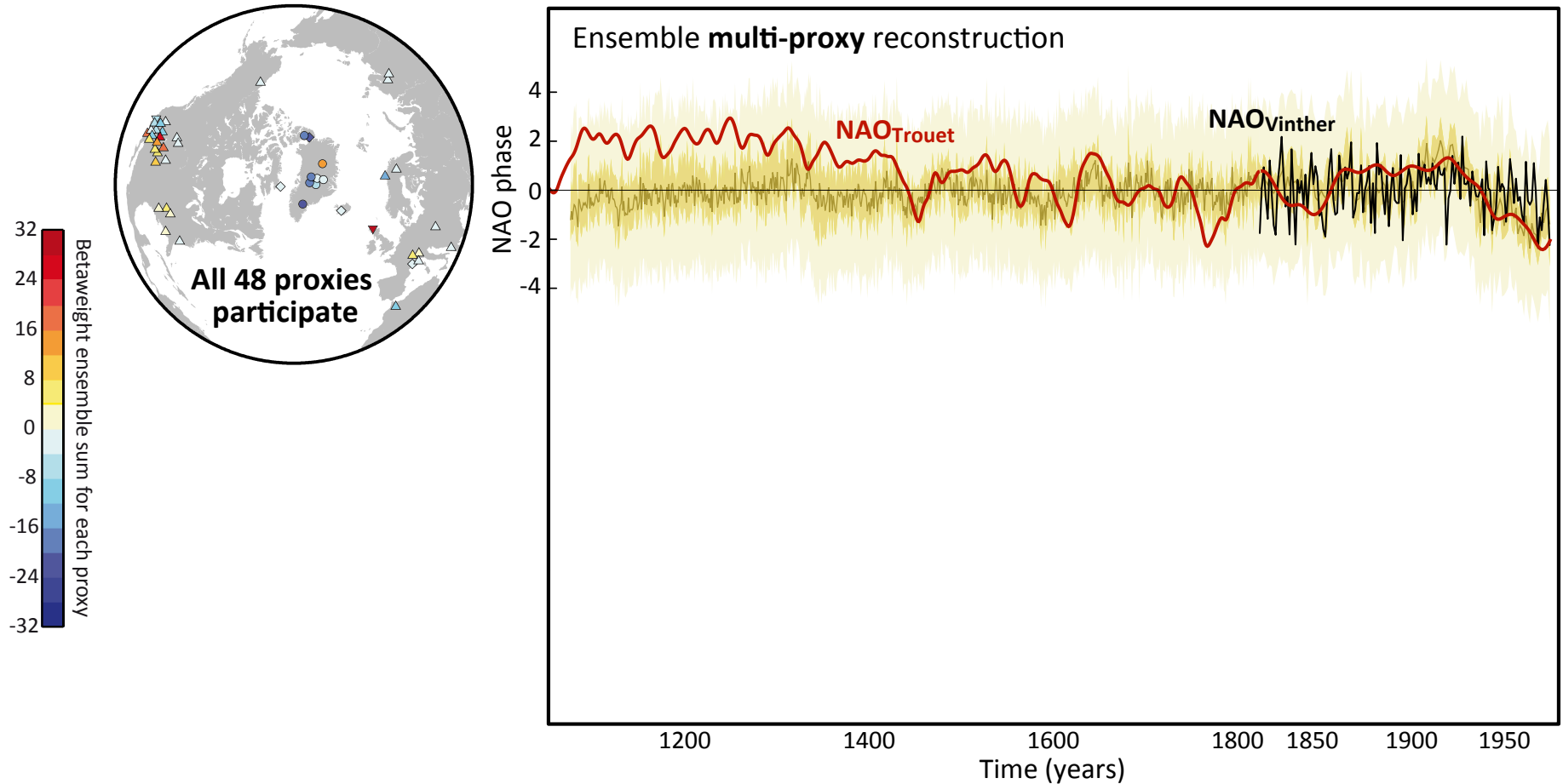
Paleoclimate Modelling
PMIP₄
Intercomparison Project

Past2k: Jungclaus et al (2017)

midHolocene: Otto-Bliesner et al (2017)

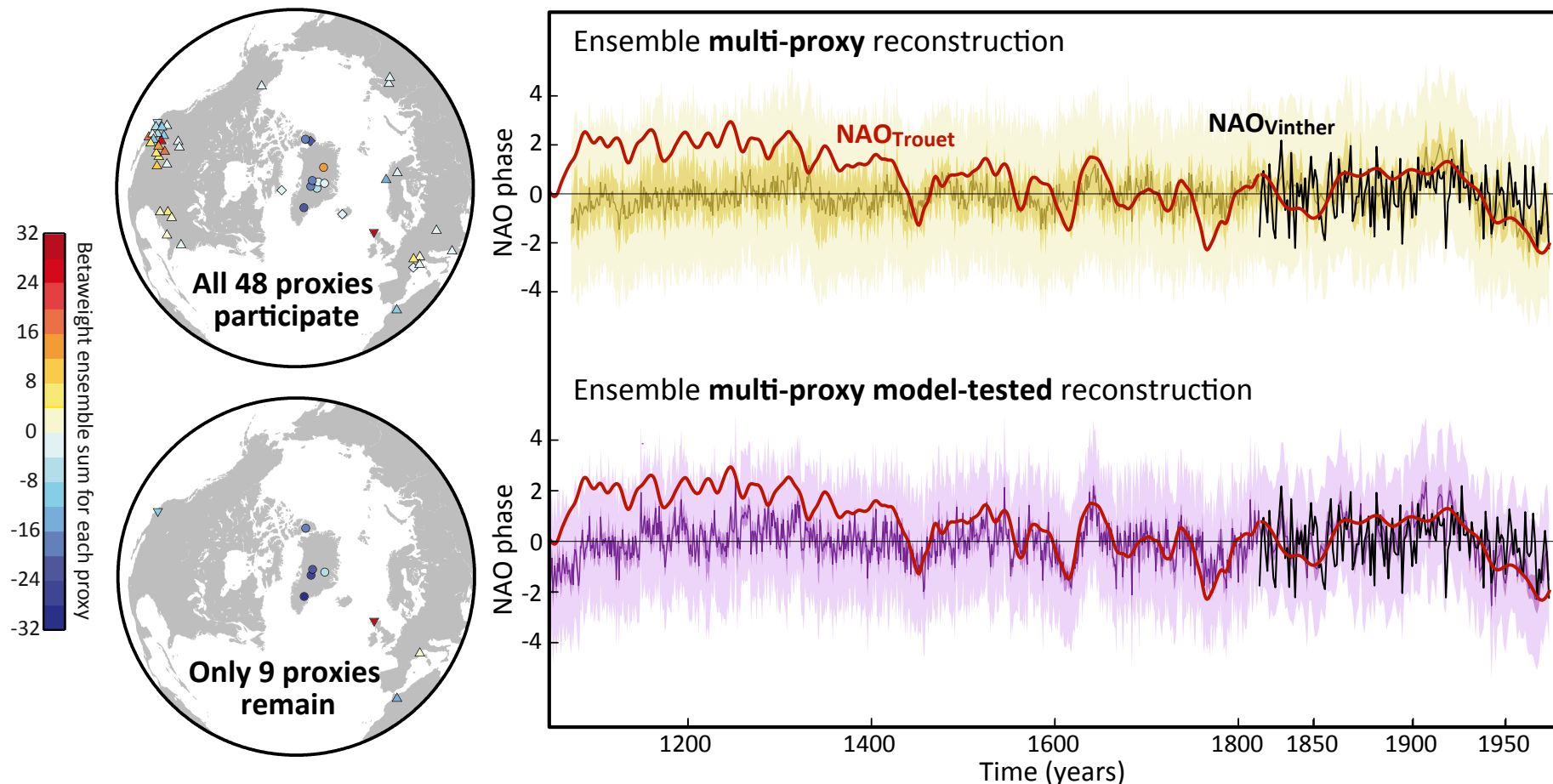
A multi-proxy NAO reconstruction

Ortega et al (2015)



A multi-proxy model-tested NAO reconstruction

Ortega et al (2015)

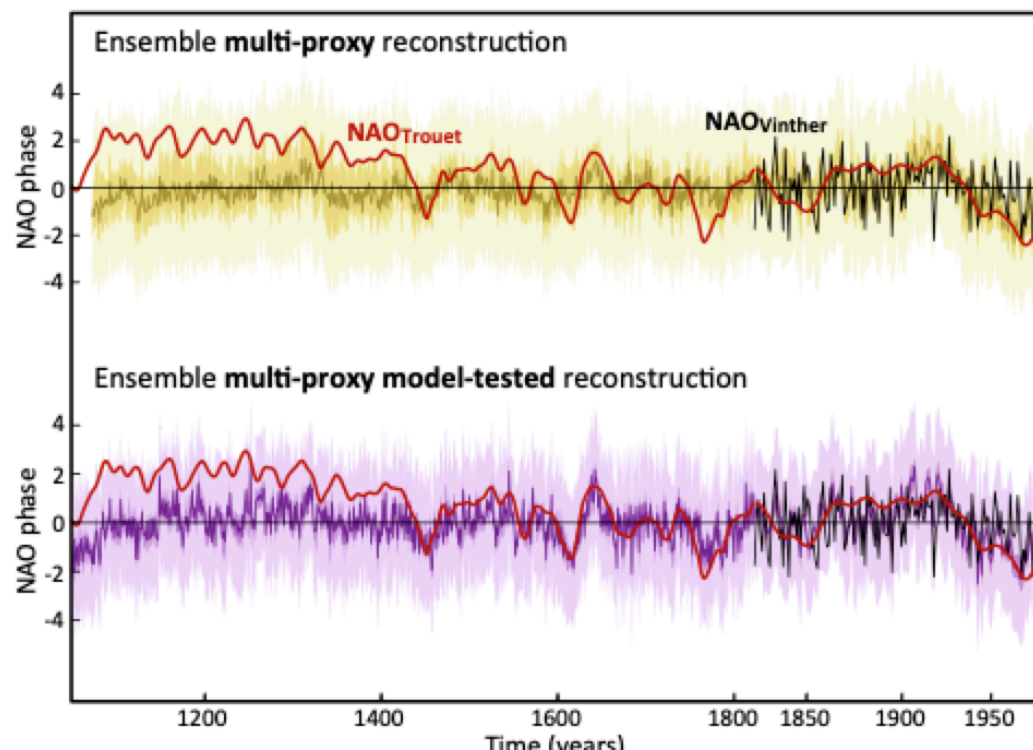
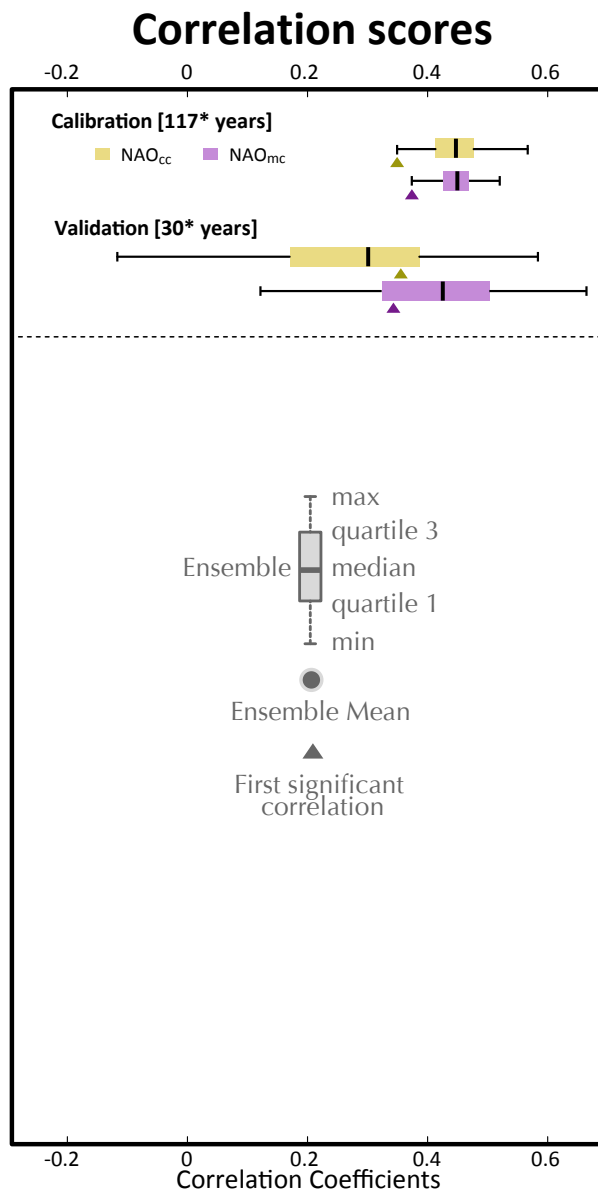


Assessment with 8 last millennium simulations and 4 reanalyses

We keep proxies supported by at least 4/8 simulations and 1/4 reanalyses

Validation of the ensemble reconstructions

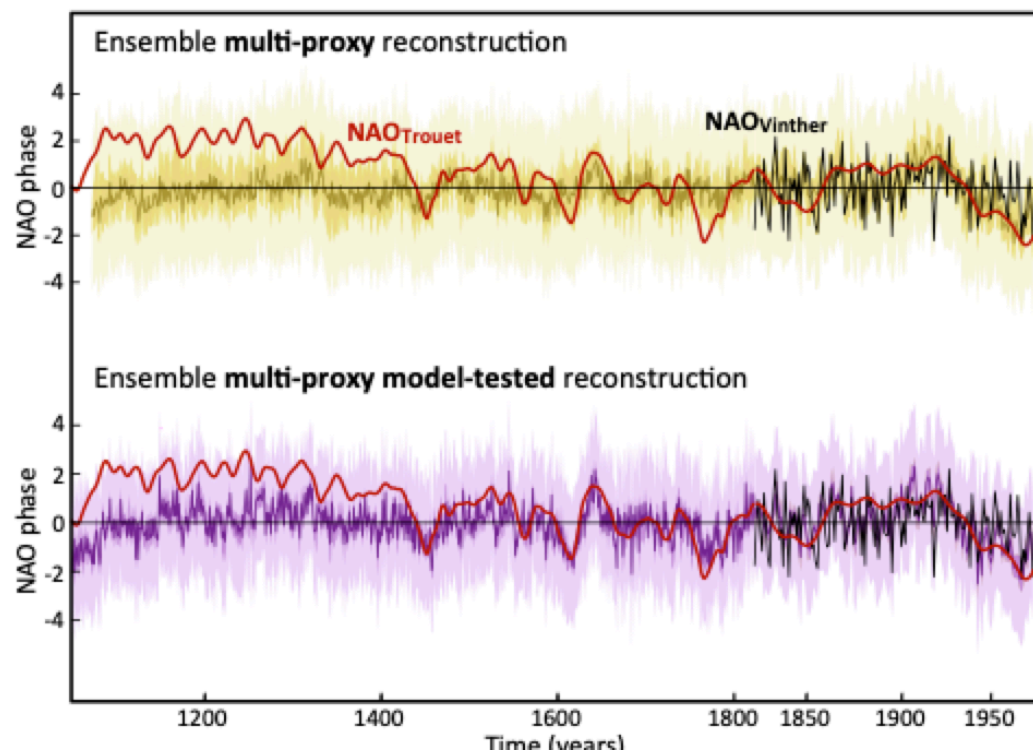
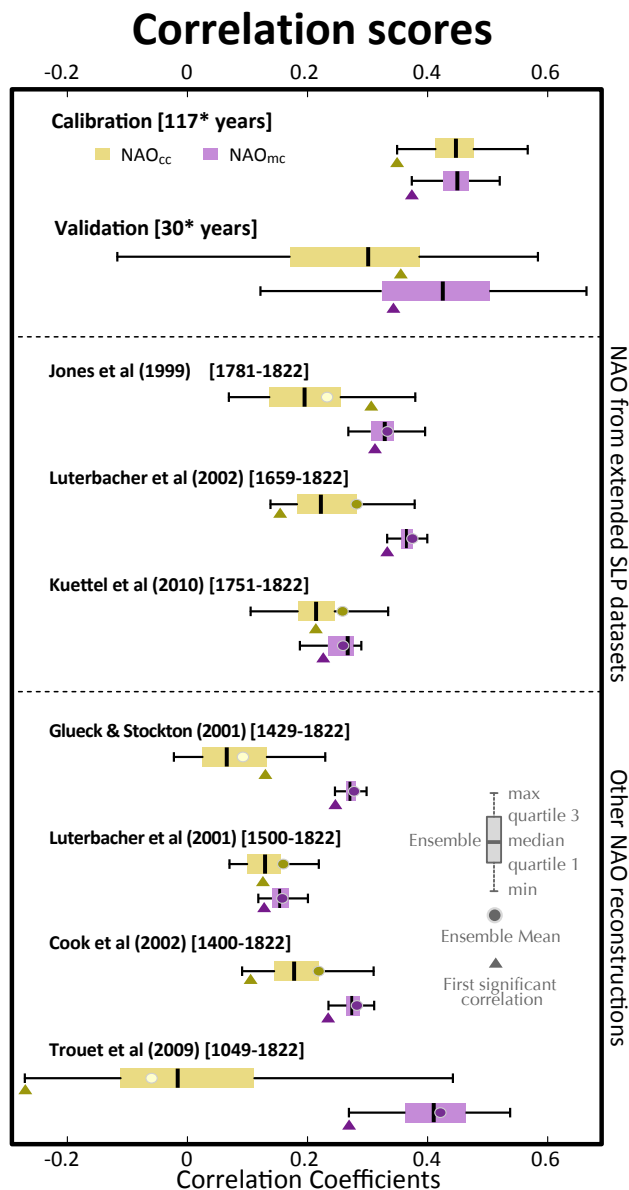
Ortega et al (2015)



By constraining with models we improve the validation scores and therefore the reliability of the reconstruction

Validation of the ensemble reconstructions

Ortega et al (2015)

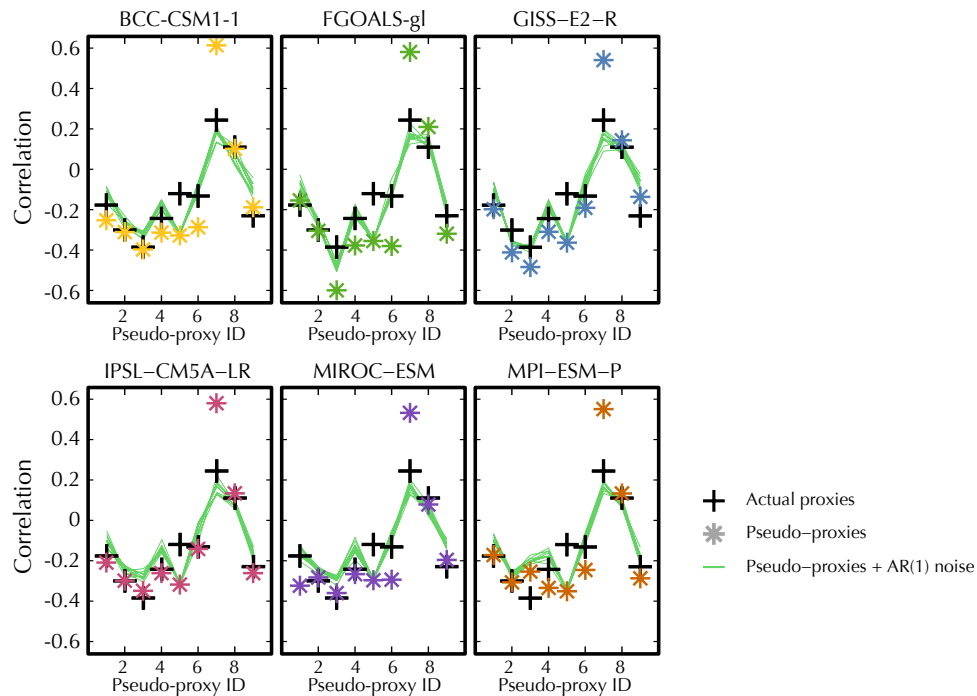


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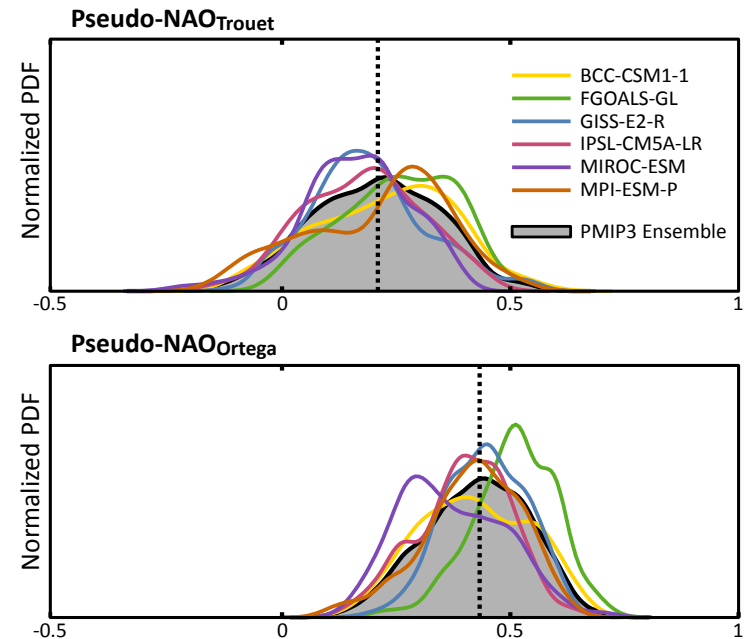
Testing the stability and reliability of the reconstruction

*Using the models as a **surrogate reality** we can compare the robustness through time of the different reconstruction approaches*

Pseudo-proxies



50-year Sliding Correlations

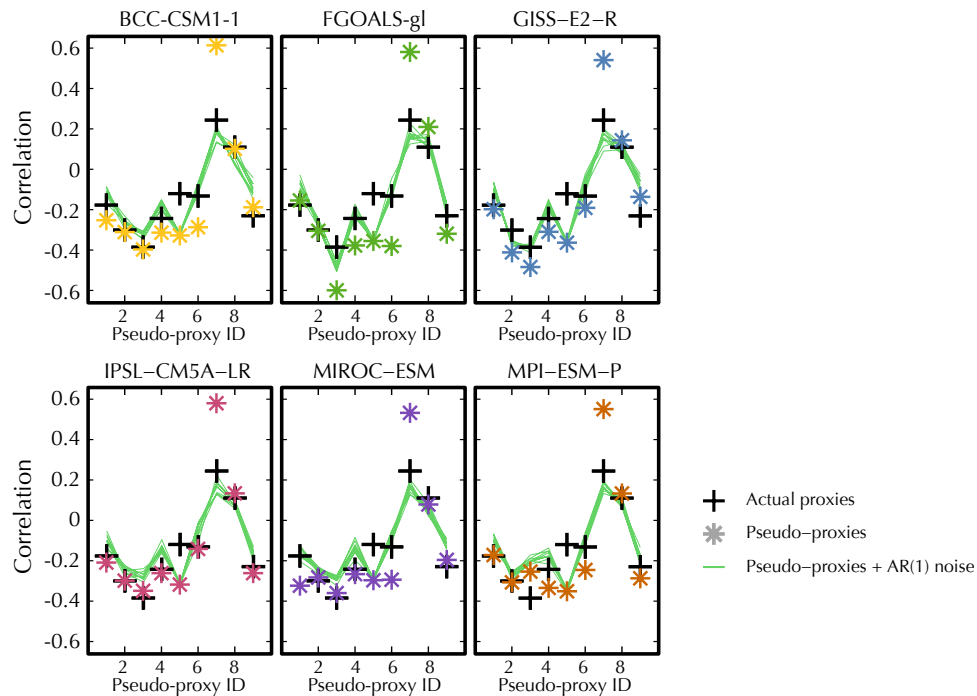


In all the last millennium simulations, the multi-proxy model-tested pseudo-reconstruction clearly outperforms the bi-proxy index

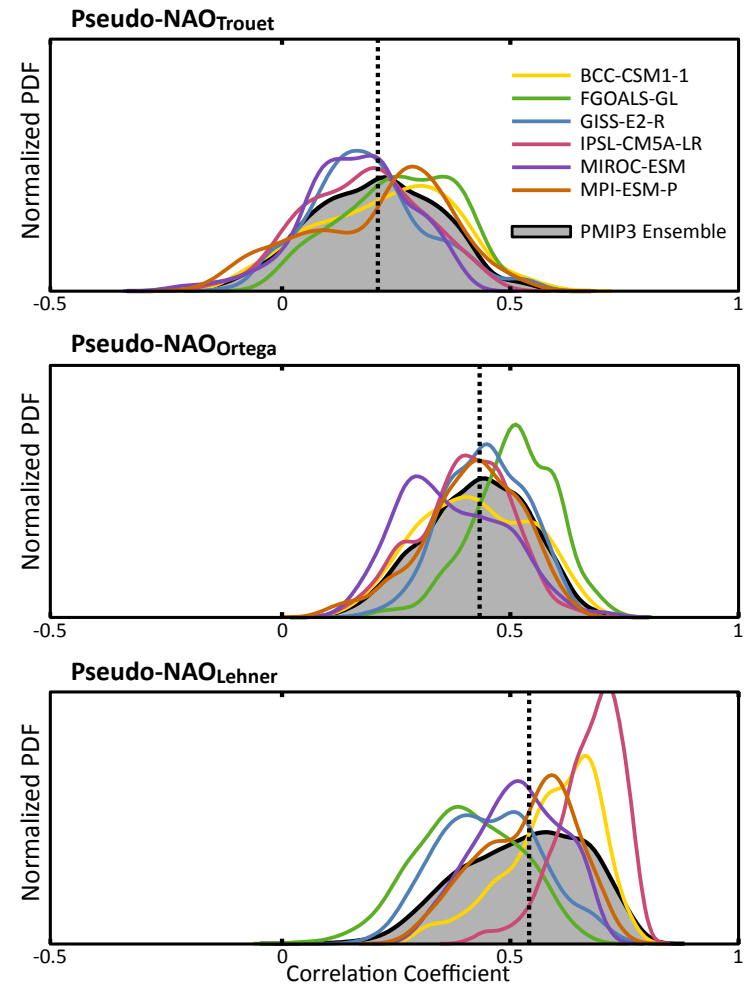
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Pseudo-proxies



50-year Sliding Correlations



However, there is still room for improvement providing new proxies for other important NAO fingerprints become available

Thank you for your attention!!!!